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Ando

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(54) **SHEET STORAGE DEVICE AND IMAGE FORMING SYSTEM THEREWITH**

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H04N 1/00 (2006.01)

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CPC ***G03G 15/6511*** (2013.01); ***H04N 1/00557*** (2013.01); ***H04N 1/00559*** (2013.01); ***H04N 1/00631*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/6511; H04N 1/00557; H04N 1/00559; H04N 1/00631
See application file for complete search history.

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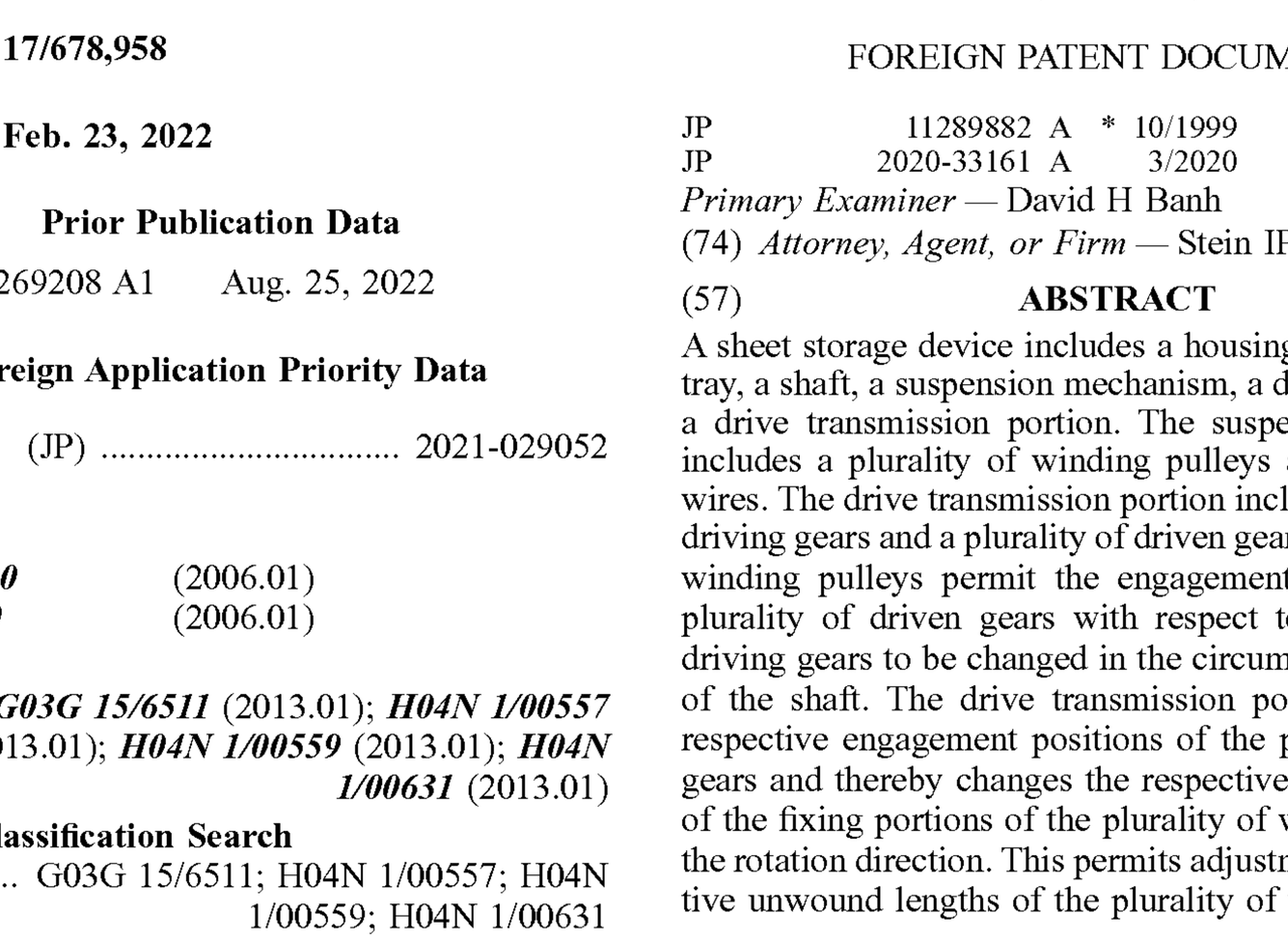
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(57) **ABSTRACT**

A sheet storage device includes a housing, a sheet stacking tray, a shaft, a suspension mechanism, a driving device, and a drive transmission portion. The suspension mechanism includes a plurality of winding pulleys and a plurality of wires. The drive transmission portion includes a plurality of driving gears and a plurality of driven gears. The plurality of winding pulleys permit the engagement positions of the plurality of driven gears with respect to the plurality of driving gears to be changed in the circumferential direction of the shaft. The drive transmission portion changes the respective engagement positions of the plurality of driven gears and thereby changes the respective relative positions of the fixing portions of the plurality of winding pulleys in the rotation direction. This permits adjustment of the respective unwound lengths of the plurality of wires.

7 Claims, 8 Drawing Sheets



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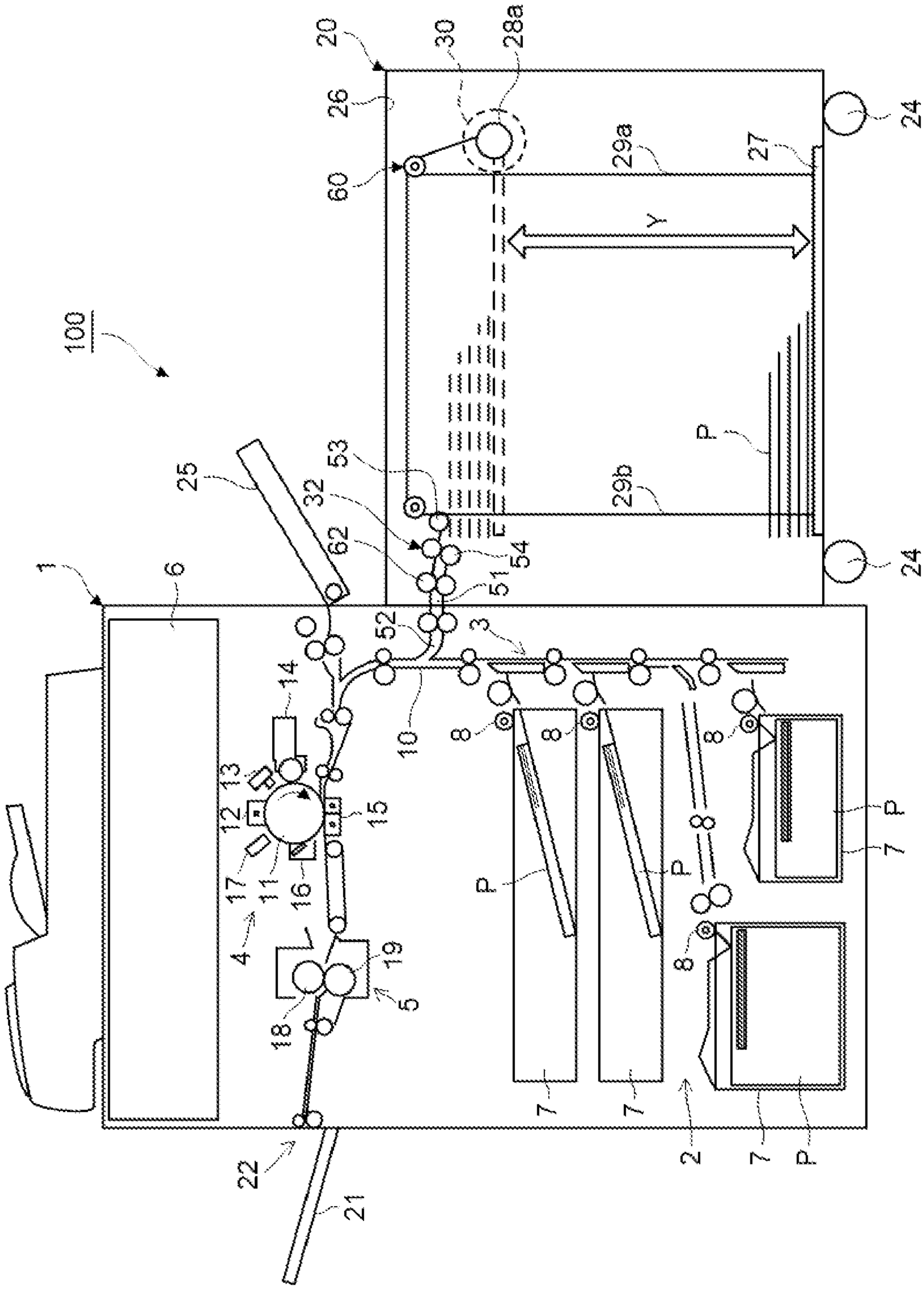

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28a
29a
29b
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P
Y
E

FIG. 1

FIG.2

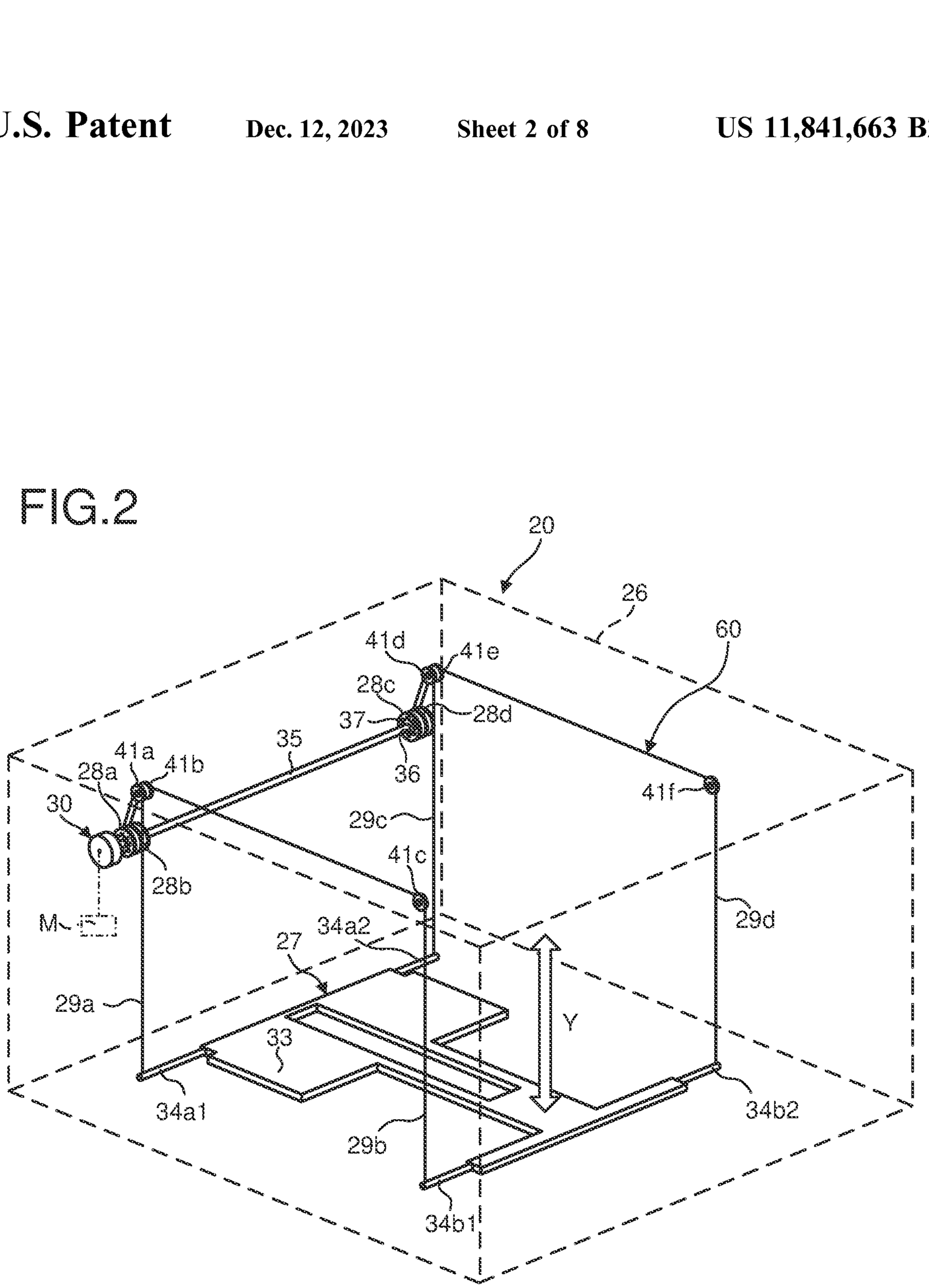

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26
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41d
41e
28c
28d
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41b
28a
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41f
29c
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M
34a2
27
29d
29a
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33
34a1
34b2
29b
34b1

FIG.3

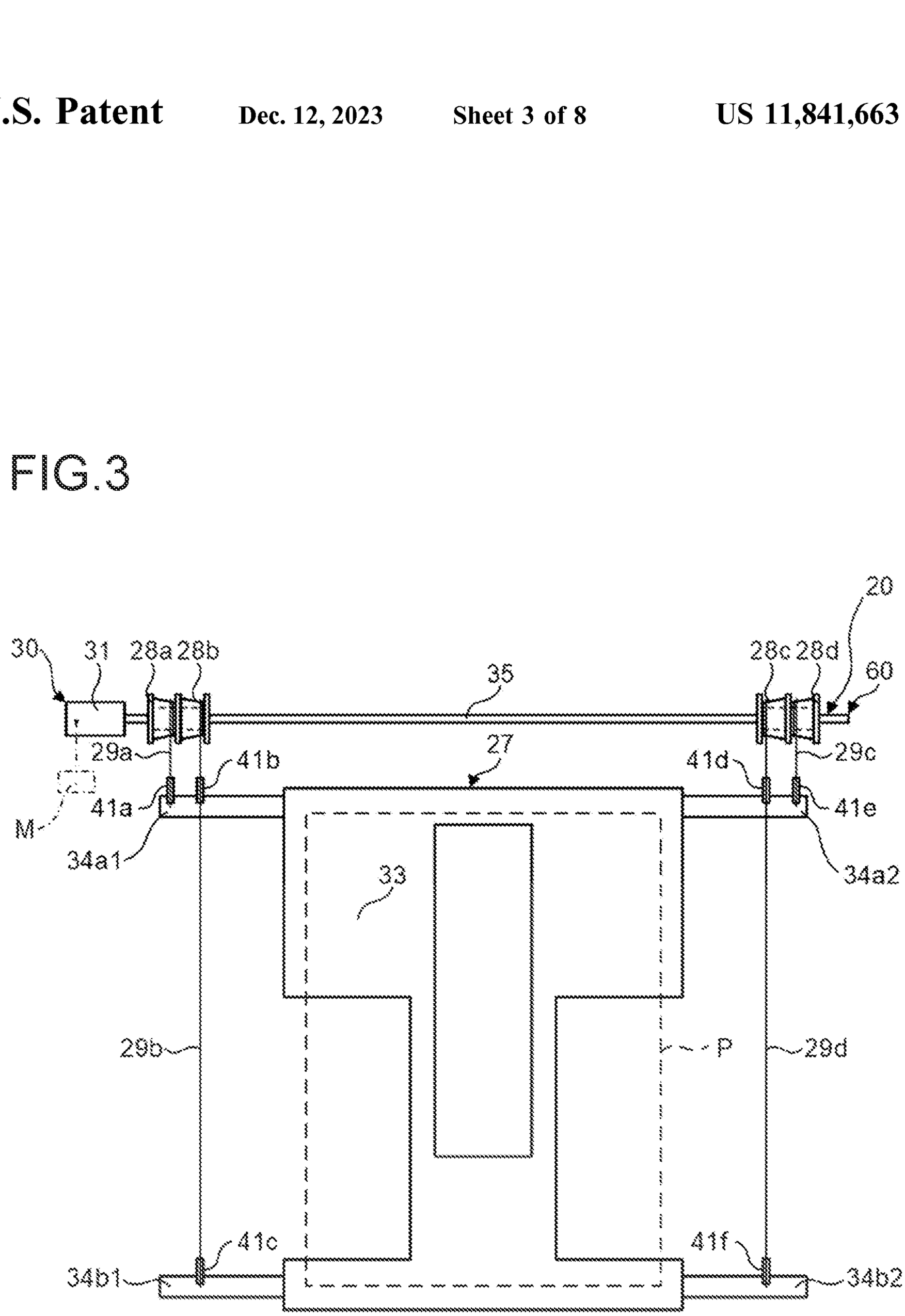

20
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28a
28b
35
28c
28d
60
29a
41b
27
29c
41d
M
41a
41e
34a1
34a2
33
29b
P
29d
41c
41f
34b1
34b2

FIG.4

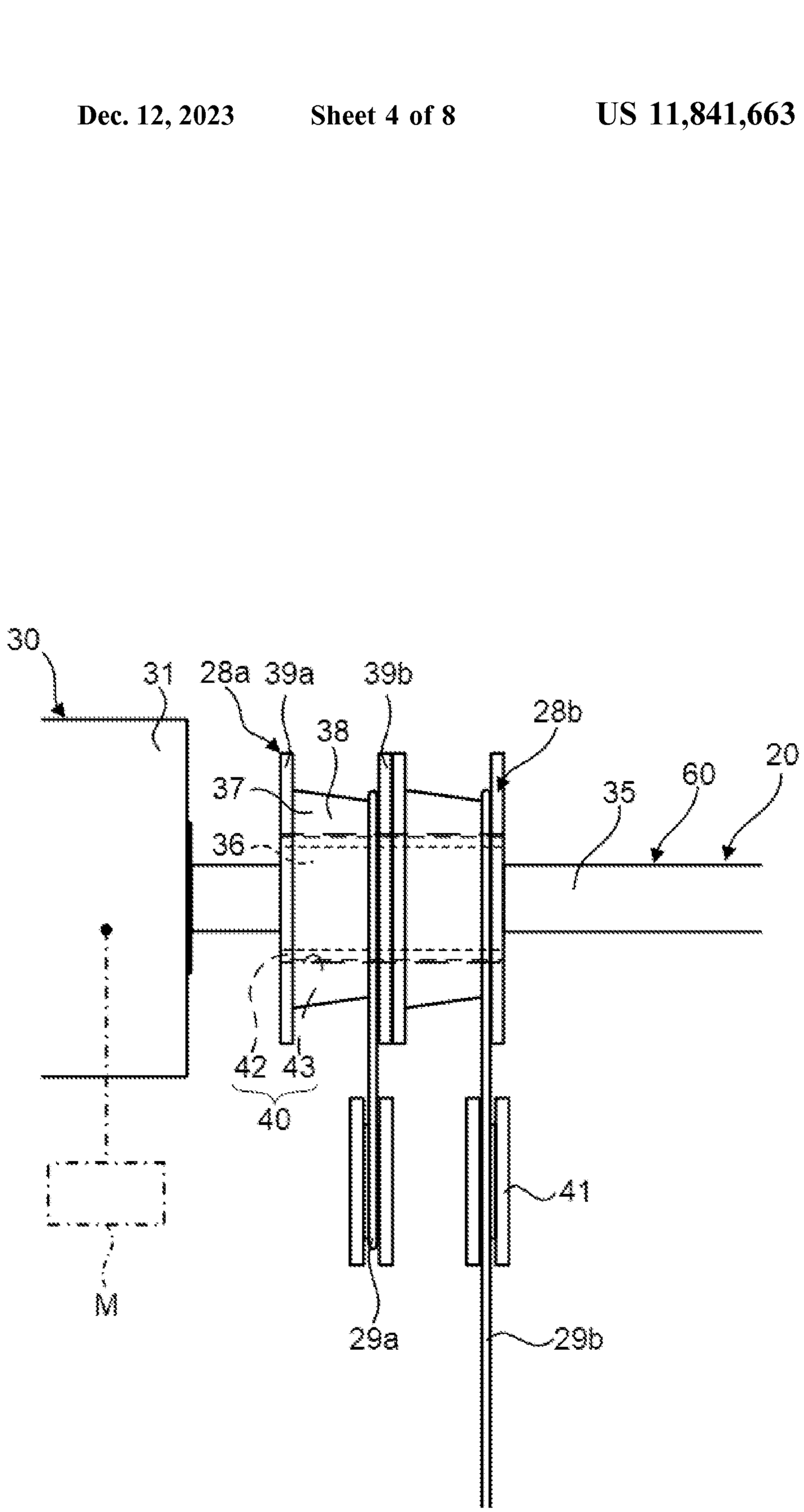


FIG.5

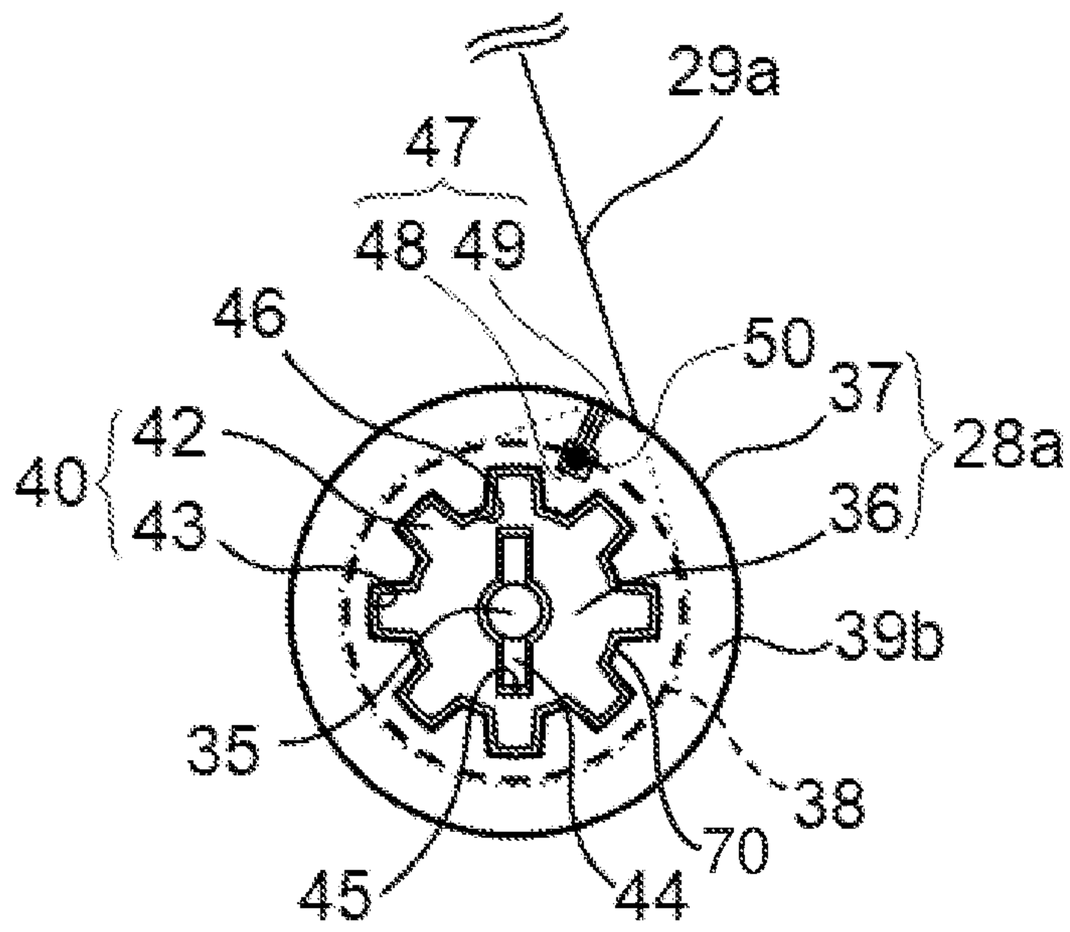


FIG.6

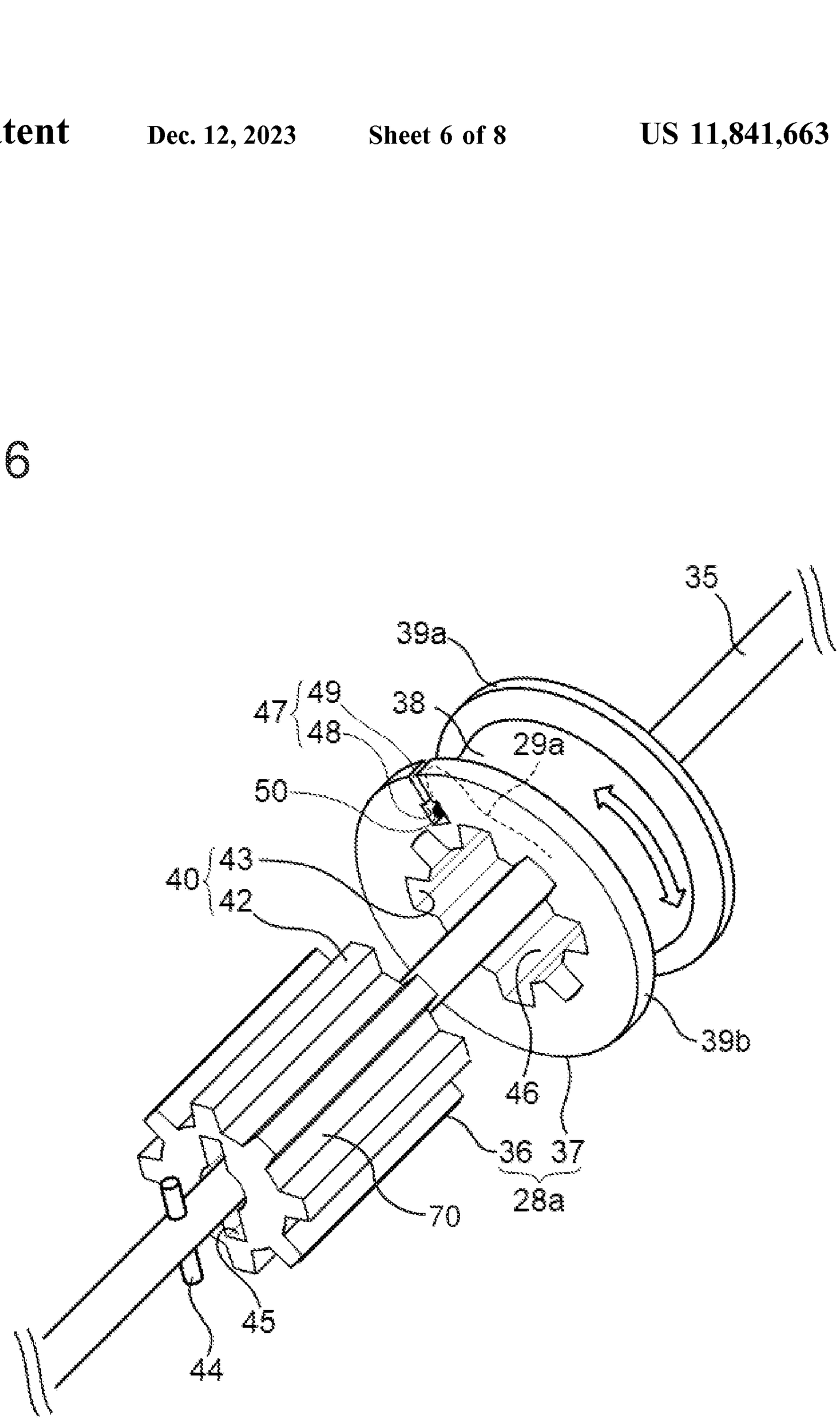


FIG.7

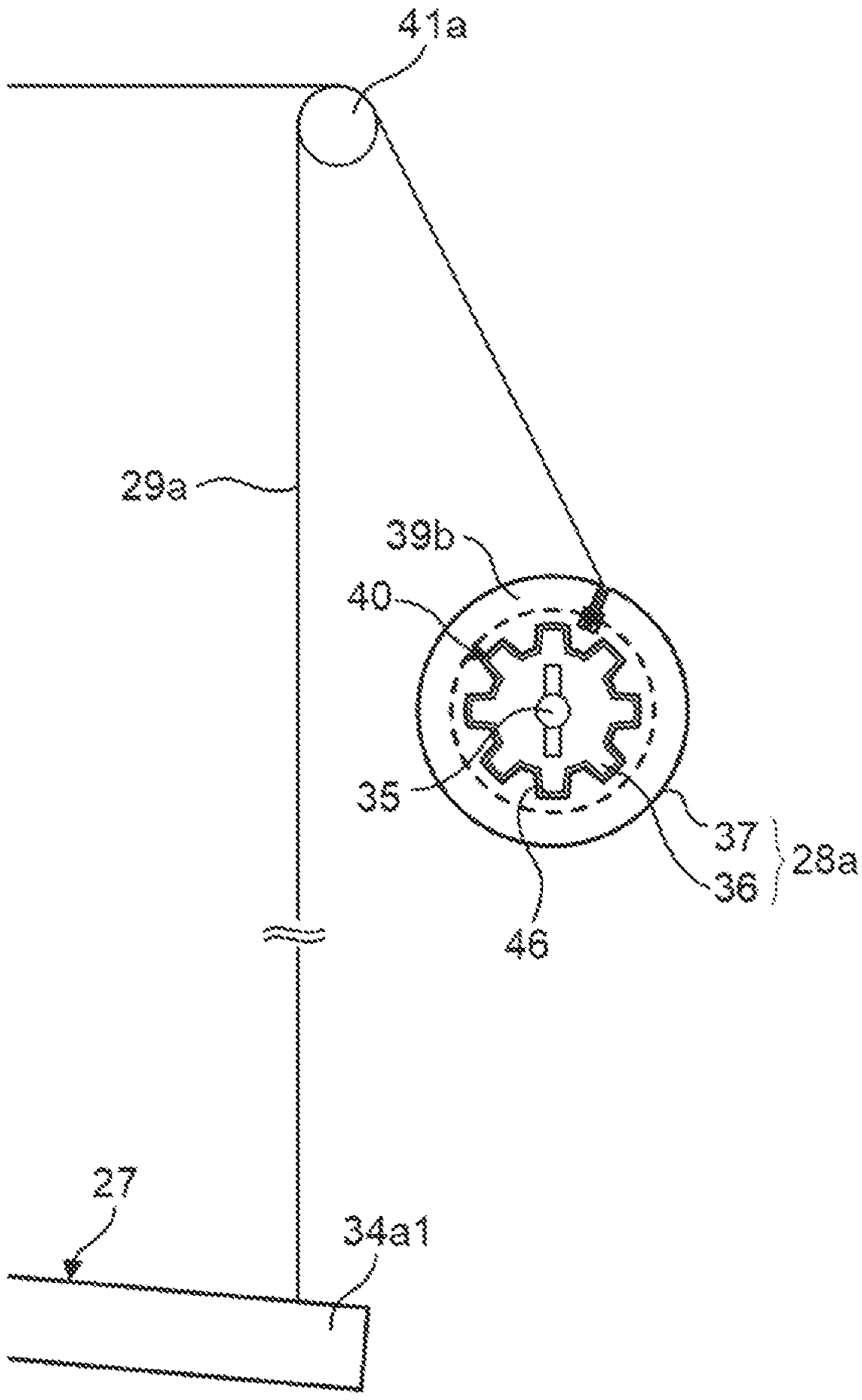
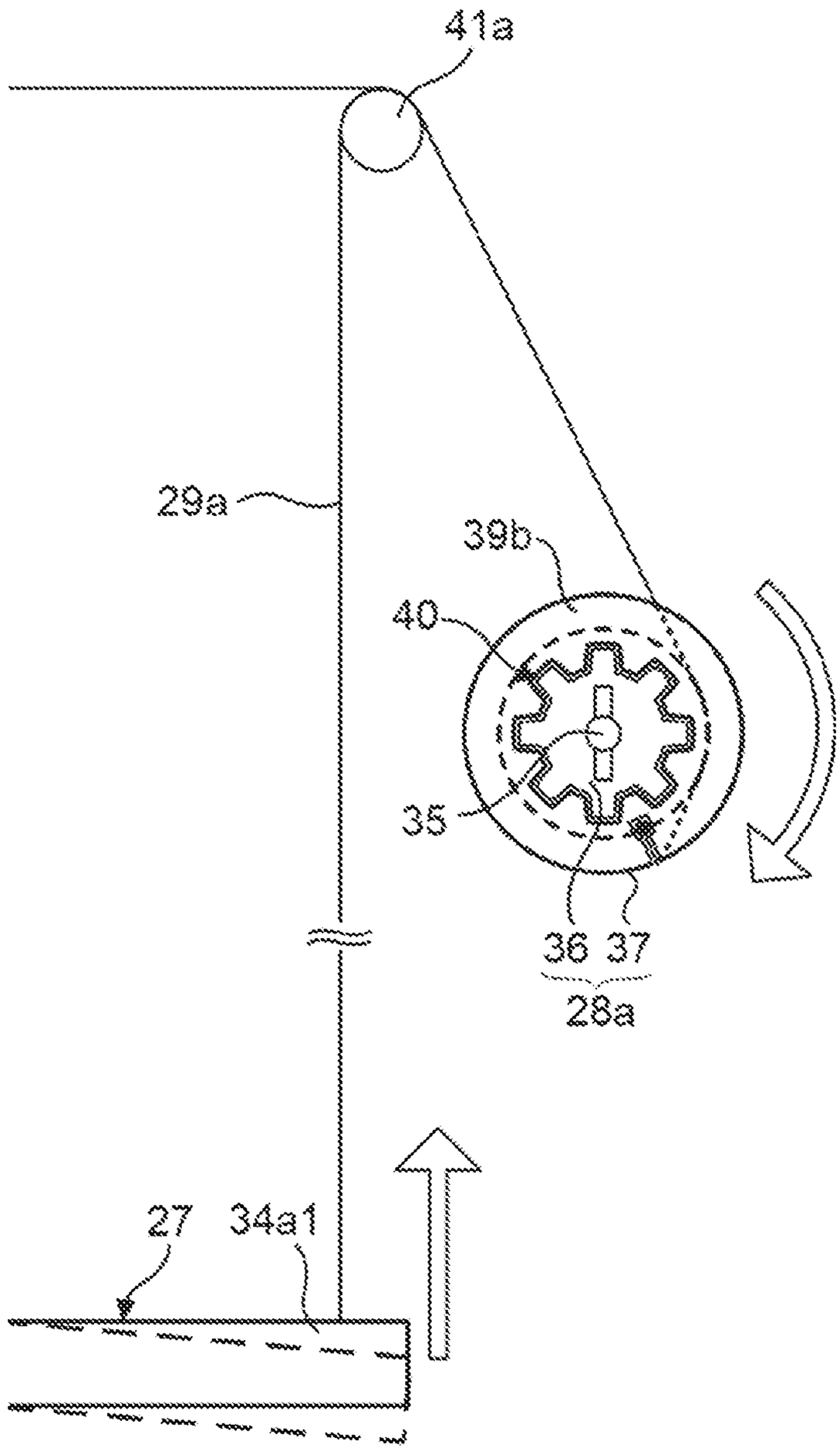


FIG.8



SHEET STORAGE DEVICE AND IMAGE FORMING SYSTEM THEREWITH

INCORPORATION BY REFERENCE

This application is based on and claims the benefit of priority from Japanese Patent Application No, 2021-029052 filed on Feb. 25, 2021, the contents of which are hereby incorporated by reference.

BACKGROUND

The present disclosure relates to a sheet storage device, and relates also to an image forming system provided with a sheet storage device.

With image forming apparatuses such as copiers, printers, and facsimile machines, in a situation where a single image forming apparatus is shared by a large number of users, increased quantities of sheets (recording media such as printing paper sheets and envelopes) are consumed per image forming apparatus. In general, an image forming apparatus can only store several hundred sheets inside its body, and thus needs to be replenished with sheets frequently. As a remedy, a large-capacity sheet storage device is known that is capable of storing several thousand sheets and that is attached to a side part of an image forming apparatus so that sheets are supplied from the sheet storage device to the image forming apparatus.

Such a sheet storage device includes a sheet stacking tray on which sheets are stacked, a suspension mechanism that suspends the sheet stacking tray, and a driving device that applies a rotative driving force to the suspension mechanism to raise and lower the sheet stacking tray. The suspension mechanism includes a shaft that is supported so as to be rotatable in forward and reverse directions, a plurality of pulleys that are attached to the opposite ends of the shaft in the rotation axis direction, and four wires of which one ends are fixed to the pulleys and of which the other ends are fixed to the sheet stacking tray.

The driving device is connected to the shaft, and applies a rotative driving force to the shaft to make it rotate. The pulleys are restrained from rotating relative to the shaft, and rotate together with the shaft as it rotates. The driving device, by rotating the shaft and pulleys, winds the wires around the pulleys and unwinds the wires from the pulleys, thereby to raise and lower the sheet stacking tray. That is, the unwound length of the wires varies with the number of revolutions of the pulleys.

The other ends of the wires are fixed to fixing portions provided at the four corners of the sheet stacking tray. The fixing portions are disposed such that the center of gravity of the sheet stacking tray overlaps the center of those fixing portions. The unwound length of the wires is equal for all the wires, so that the sheet stacking tray ascends and descends in a state suspended in a horizontal state by the wires.

Above the sheet stacking tray, a sheet feed portion is disposed that feeds sheets from the sheet storage device to the image forming apparatus. With the sheet stacking tray raised such that the top surface of the bundle of sheets stacked on the sheet stacking tray is in contact with the sheet feed portion, the sheet feed portion feeds out the sheet in contact with it to the image forming apparatus.

SUMMARY

According to one aspect of the present disclosure, a sheet storage device includes a housing, a sheet stacking tray, a shaft, a suspension mechanism, a driving device, and a drive transmission portion. The sheet stacking tray is supported inside the housing so as to be able to lift up and down in an ascent-descent direction, and on the sheet stacking tray, sheets are stacked. The shaft extends in a direction orthogonal to the ascent-descent direction, and is supported so as to be rotatable in forward and reverse directions The suspension mechanism includes a plurality of winding pulleys fitted at opposite ends of the shaft and a plurality of wires of which one ends are respectively fixed to the plurality of winding pulleys and of which the other ends are fixed to the sheet stacking tray so as to suspend the sheet stacking tray. The driving device rotates the shaft. The drive transmission portion includes a plurality of driving gears that are respectively fixed at positions corresponding to the plurality of winding pulleys on the shaft and that rotate to with the shaft and a plurality of driven gears that are respectively formed on the plurality of winding pulleys and that are engageable with corresponding ones of the plurality of driving gears. In the drive transmission portion, the plurality of driving gears and the plurality of driven gears engage with each other to transmit the rotation of the shaft to the plurality of winding pulleys. The plurality of winding pulleys have fixing portions to which end parts of the plurality of wires are fixed, and permit the engagement positions of the plurality of driven gears with respect to the plurality of driving gears to be changed in the circumferential direction of the shaft. The drive transmission portion changes the respective engagement positions of the plurality of driven gears, and thereby changes the respective relative positions of the fixing portions of the plurality of winding pulleys in a rotation direction, so as to allow adjustment of the respective unwound lengths of the plurality of wires.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an outline sectional view showing an outline of the construction of an image forming system that includes a sheet storage device according to an embodiment of the present disclosure and an image forming apparatus;

FIG. **2** is a perspective view showing the structure inside a housing of the sheet storage device;

FIG. **3** is a plan view of the sheet storage device shown in FIG. **2** as seen from above;

FIG. **4** is a plan view around an end part of a shaft at one side;

FIG. **5** is a plan view of a first pulley as seen from inward of it in the axial direction;

FIG. **6** is a perspective view of the first pulley, showing its structure exploded;

FIG. **7** is a side view of a suspension mechanism suspending the sheet stacking tray in an inclined state; and

FIG. **8** is a side view of the suspension mechanism in a state where, as a result of the driven gear shown in FIG. **7** being rotated through a predetermined angle in the forward direction, the unwound length has been reduced.

DETAILED DESCRIPTION

With reference to the accompanying drawings, a description will be given of a sheet storage device **20** according to the present disclosure and an image forming system **100** that includes the sheet storage device **20**.

FIG. **1** is an outline sectional view showing an outline of the construction of an image forming system **100** that includes the sheet storage device **20** according to the embodiment of the present disclosure and an image forming

apparatus **1**. The image forming apparatus **1** includes a sheet feed portion **2**, a sheet conveyance portion **3**, an image forming portion **4**, a fixing device **5**, and an image reading portion **6**. The sheet feed portion **2** is disposed in a lower part of the image forming apparatus **1**. The sheet conveyance portion **3** is disposed by the side of the sheet feed portion **2**. The image forming portion **4** is disposed over the sheet conveyance portion **3**. The fixing device **5** is disposed on the discharge side of the image forming portion **4**. The image reading portion **6** is disposed over the image forming portion **4** and the fixing device **5**.

The sheet feed portion **2** includes a plurality of sheet feed cassettes **7** that store sheets P of plain paper. As a sheet feed roller **8** rotates, the sheet feed portion **2** feeds out the sheets P one by one reliably from a selected one of the plurality of sheet feed cassettes **7**.

A hand feed tray **25** is for stacking, and for feeding out to the sheet conveyance portion **3**, sheets of pain paper of a size different from the sizes of the sheets P stored in the sheet feed cassettes **7**, or OHP sheets, or sheets like envelopes.

A sheet P fed to the sheet conveyance portion **3** is conveyed through a sheet feed passage **10** toward the image forming portion **4**. The sheet feed passage **10** extends upward from the sheet feed cassettes **7**, and midway meets a confluence passage **52** that is connected to a sheet discharge port **51** (described later) of the sheet storage device **20**.

The image forming portion **4** forms a toner image on a sheet P by a electrophotographic process. The image forming portion **4** includes a photosensitive member **11** pivoted so as to be rotatable in the direction indicated by an arrow in FIG. **1**, and further includes, around the photosensitive member **11** along its rotation direction, a charging portion **12**, an exposure portion **13**, a developing device **14**, a transfer portion **15**, a cleaning portion **16**, and a destaticizing portion **17**.

The charging portion **12** includes a charging wire supplied with a high voltage. When through corona discharge from this charging wire a predetermined potential is applied to the surface of the photosensitive member **11**, the surface of the photosensitive member **11** is electrostatically charged uniformly. When light based on the image data of a document read by the image reading portion **6** is shone on the photosensitive member **11** from the exposure portion **13**, the surface potential on the photosensitive member **11** is attenuated selectively from place to place, so that an electrostatic latent image is formed on the surface of the photosensitive member **11**.

The developing device **14** then develops the electrostatic latent image on the surface of the photosensitive member **11**, so that a toner image is formed on the surface of the photosensitive member **11**. The toner image is transferred by the transfer portion **15** to the sheet P fed to between the photosensitive member **11** and the transfer portion **15**.

The sheet P having the toner image transferred to it is conveyed toward the fixing device **5**, which is disposed downstream of the image forming portion **4** in the sheet conveyance direction. In the fixing device **5**, the sheet P is heated and pressed by a heating roller **18** and a pressing roller **18**, so that the toner image is fused to be fixed to the sheet P. The sheet P having the toner image fixed to it is then discharged onto a discharge tray **21** by a pair of discharge rollers **22**.

After the transfer in the transfer portion **15**, the toner remaining on the surface of the photosensitive member **11** is removed by the cleaning portion **16**, and the electric charge remaining on the surface of the photosensitive member **11** is eliminated by the destaticizing portion **17**. The photosensitive member **11** is then electrostatically charged again by the charging portion **12**, so that image formation continues in a similar manner.

By the side of the image forming apparatus **1**, adjacent to it, a large-capacity sheet storage device **20** is disposed that can store several thousand sheets P. The sheet storage device **20** includes, inside a housing **26** that forms the body of the sheet storage device **20**, a sheet stacking tray **27**, a suspension mechanism **60**, a first wire **29***a*, a second wire **29***b*, a third wire **29***c*, a fourth wire **29***d*, a driving device **30**, and a sheet feed mechanism **32**. The housing **26** is formed substantially in the shape of a rectangular parallelepiped. To the bottom surface of the housing **26**, a plurality of casters **24** are fitted to allow easy transport of the sheet storage device **20**.

FIG. **2** is a perspective view showing the structure inside the housing **26** of the sheet storage device **20**. FIG. **3** is a plan view of the sheet stacking tray **27** shown in FIG. **2** as seen from above. The far right side surface of the housing **26** in FIG. **2** corresponds to the front side surface in FIG. **1** with respect to its plane. The near left side surface of the housing **26** in FIG. **2** corresponds to the rear side surface in FIG. **1** with respect to its plane. The width direction of the sheets P stored in the sheet storage device **20** points in the same direction as the direction from the front to the rear of the housing **26**.

As shown in FIGS. **2** and **3**, the sheet stacking tray **27** includes a tray portion **33**, which is a plate-shaped member in a rectangular shape extending parallel to the horizontal plane, and fixing portions **34***a***1**, **34***a***2**, **34***b***1**, and **34***b***2** (upstream fixing portions and downstream fixing portions), which protrude from the four corners of the tray portion **33** outward in its width direction (the width direction of the sheets P). The sheet stacking tray **27** is supported inside the housing **26** so as to be able to lift up and down along the up-down direction (direction indicated by arrow Y FIG. **2**). The sheets P are stacked on a central part (at the position indicated by broken line in FIG. **3**) of the tray portion **33**.

The fixing portions **34***a***1**, **34***a***2**, **34***b***1**, and **34***b***2** include a pair of fixing portions **34***a***1** and **34***a***2** (upstream fixing portions) that are located in an upstream end part of the tray portion **33** with respect to the sheet conveyance direction and a pair of fixing portions **34***b***1** and **34***b***2** (downstream fixing portions) that are located in a downstream end part of the tray portion **33** with respect to the sheet conveyance direction. The fixing portions **34***a***1** and **34***a***2** are disposed respectively at one side (at the front side (at the front side of the image forming apparatus **1**)) and at the other side (at the rear side (at the rear side of the image forming apparatus **1**)) along the axial direction. The fixing portions **34***b***1** and **34***b***2** are disposed respectively at one side (at the front side (at the rear side of the image forming apparatus **1**)) and at the other side (at the rear side (at the rear side of the image forming apparatus **1**)) along the axial direction.

The suspension mechanism **60** suspends the sheet stacking tray **27** via a plurality of (here, four) wires **29***a* to **29***d* (the first, second, third, and fourth wires **29***a*, **29***b*, **29***c*, and **29***d*) such that the sheet stacking tray **27** is able to lift up and down inside the housing **26**. The suspension mechanism **60** includes a shaft **35**, a plurality of pulleys **28***a* to **28***d* (winding pulleys), and sheaves **41***a* to **41***f*. The plurality of pulleys **28***a* to **28***d* will be referred to individually as the first pulley **28***a* (front pulley), the second pulley **28***b* (fixing portion), the third pulley **28***c* (rear pulley), and the fourth pulley **28***d* (rear pulley).

The shaft **35** extends along a horizontal direction (the width direction of the sheets P) orthogonal to the ascent-descent direction of the sheet stacking tray **27**. The shaft **35** is supported inside the housing **26** so as to be rotatable in forward and reverse directions (clockwise and counter-clockwise about the center axis of the shaft **35** as a rotation axis). The shaft **35** is fitted, at its opposite ends with respect to the direction (hereinafter referred to as the "axial direction") along the rotation axis of the shaft **35**, with a plurality of pulleys **28***a* to **28***d* (here, four pulleys, namely the first, second, third, and fourth pulleys **28***a*, **28***b*, **28***c*, and **28***d*).

To an end part of the shaft **35** at one side in the axial direction (an end part at the rear side of the image forming apparatus **1**), a driving device **30** is connected. The driving device **30** includes a drive portion M, such as a motor, that can apply a rotative driving force and a drive input gear **31** that is connected to the drive portion M and the shaft **35**. The drive input gear **31** is composed of a plurality of gears, and transmits the rotative driving force of the drive portion M to the shaft **35**. The driving device **30** makes the drive portion M generate a rotative driving force in a forward or reverse direction, and thereby makes, via the drive input gear **31**, the shaft **35** rotate in a forward or reverse direction.

As shown in FIGS. **2** and **3**, to an end part of the shaft **35** at one side in the axial direction (an end part at the rear side of the image forming apparatus **1**), inward of the driving device **30** in the axial direction, the first and second pulleys **28***a* and **28***b* are fitted. To an end part of the shaft **35** at the other side (opposite from the one side mentioned above) in the axial direction (an end part at the front side of the image forming apparatus **1**), the third and fourth pulleys **28***c* and **28***d* are fitted.

The pulleys **28***a* to **28***d* are located coaxially with respect to the shaft **35**. The first and second pulleys **28***a* and **28***b* are adjacent to and in contact with each other in the axial direction. The first pulley **28***a* is located outward of the second pulley **28***b* in the axial direction. The third and fourth pulleys **28***c* and **28***d* are adjacent to and in contact with each other in the axial direction. The third pulley **28***c* is located inward of the fourth pulley **28***d* in the axial direction. The pulleys **28***a*, to **28***d* are members that are separate from each other, and are separable from each other.

To the first pulley **28***a*, one end of the first wire **29***a* is fixed. To the second pulley **28***b*, one end of the second wire **29***b* is fixed. To the third pulley **28***c*, one end of the third wire **29***c* is fixed. To the fourth pulley **28***d*, one end of the fourth wire **29***d* is fixed. As the pulleys **28***a* to **28***d* rotate in the forward direction, the wires **29***a* to **29***d* that are fixed with respect to those pulleys **28***a* to **28***d* are wound up. By contrast, as the pulleys **28***a* to **28***d* rotate in the reverse direction, the wires **29***a* to **29***d* that are fixed with respect to those pulleys are unwound out.

FIG. **4** is a plan view around an end part of the shaft **35** at one side. FIG. **5** is a plan view of the first pulley **28***a* as seen from inward of it in the axial direction. FIG. **6** is an exploded perspective view of the first pulley **28***a*. The pulleys **28***a* to **28***d* are identically shaped and identically structured; accordingly only the first pulley **28***a* will be described in detail below, and for the other pulleys (second, third, and fourth pulleys **28***b*, **28***c*, and **28***d*), the same reference signs will be shared, with no overlapping description repeated.

As shown in FIGS. **4**, **5**, and **6**, the first pulley **28***a* includes a driving gear **36** and a driven gear **37** located coaxially with the shaft **35** and a locking mechanism **40** disposed between the driving and driven gears **36** and **37**.

The driving gear **36** is a external gear that has a plurality of projections **42** formed on its outer circumferential surface **70**. The driving gear **36** is at its center in the diametrical direction penetrated by the shaft **35**. The shaft **35** is restrained from rotating relative to the shaft **35**. The projections **42** are arranged at equal intervals in the circumferential direction.

Here, at a position overlapping the driven gear **37** with respect to the axial direction, an anti-rotation pin **44** is provided that penetrates the shaft **35** in the diametrical direction (see FIG. **6**). The anti-rotation pin **44** is supported so as to be insertable in and removable from the shaft **35**. In an end surface of the driving gear **36** at one side in the axial direction, a positioning groove **45** is formed in which the anti-rotation pin **44** can be fitted. The width of the positioning groove **45** is slightly greater than the diameter of the anti-rotation pin **44**. The length and depth of the positioning groove **45** are greater than the length and diameter, respectively, of the anti-rotation pin **44**.

With the anti-rotation pin **44** fitted in the positioning groove **45**, as the shaft **35** rotates, the outer circumferential surface of the anti-rotation pin **44** makes contact with the inner wall of the positioning groove **45**. This restrains relative rotation between the shaft **35** and the driving gear **36** (these are restrained from rotating relative to each other), and the shaft **35** and the driving gear **36** rotate together. The driving gear **36** and the shaft **35** may be bonded together with adhesive or the like, or may be engaged together so as to be attachable and detachable through engagement of the positioning groove **45** with the anti-rotation pin **44**, by press-fitting the anti-rotation pin **44** into the positioning groove **45**. The anti-rotation pin **44** is provided at the position overlapping the driven gear **37** of each of the pulleys **28***a* to **28***d*.

As shown in FIGS. **4**, **5**, and **6**, the driven gear **37** has a winding portion **38** that is located in the middle of the first pulley **28***a* in the axial direction, an outer flange **39***a* formed in an end part of the winding portion **38** at one side in the axial direction (outward in the axial direction), and an inner flange **39***b* formed in an end part of the winding portion **38** at the other side in the axial direction (inward in the axial direction). At the center of the driven gear **37** in the diametrical direction, a shaft bore **46** is formed that penetrates it in the axial direction.

The first pulley **28***a* winds up the first wire **29***a* such that the first wire **29***a* is wound around the outer circumferential surface of the winding portion **38**. The winding portion **38** has a tapered shape such that its outer diameter increases toward one side in the axial direction (outward in the axial direction).

In the inner circumferential surface of the shaft bore **46**, a plurality of recesses **43** are formed that are arranged at equal intervals in the circumferential direction. The width of the recess **43** (the distance between the inner walls of adjacent recesses **43** in the circumferential direction) is slightly greater than the width of the projection **42** on the driving gear **36**. The depth of the recess **43** (its dimension in the radial direction) is slightly greater than the height of the recess **43** (its dimension in the radial direction). The projections **42** on the driving gear **36** and the recesses **43** in the driven gear **37** constitute the locking mechanism **40** (drive transmission portion).

The locking mechanism **40** restrains relative rotation between the driving gear **36** and the driven gear **37**. Specifically, the driving gear **36** fits in the shaft bore **46** with the projections **42** on the driving gear **36** fitted in the recesses **43** in the driven gear **37**. As the shaft **35** and the driving gear

36 rotate, the projections 42 and the recesses 43 make contact with each other in the circumferential direction, and this restrains relative rotation between the driving gear 36 and the driven gear 37 (these are restrained from rotating relative to each other). Thus the driving gear 36 and the driven gear 37 engage together and rotate together.

The restraint position (engagement position) of relative rotation between the driven gear 37 is determined by the fitting position between the driven gear 37 and the driving gear 36 in the circumferential direction. That is, since the recesses 43 are located next to each other in the circumferential direction and the projections 42 too are located next to each other in the circumferential direction, in accordance with which of the projections 42 fits in which of the recesses 43, the restraint position of the driven gear 37 with respect to the driving gear 36 varies.

To change the restraint position of the driven gear 37, with the driving gear 36 pulled out of the shaft bore 46 (with restraint on rotation removed), the driven gear 37 is rotated relative to the driving gear 36. That is, the rotation angle (phase) of the driven gear 37 relative to the driving gear 36 is changed. The rotation angle is equal to the angles at which the recesses 43 are located next to each other. With the rotation angle of the driven gear 37 changed, the driving gear 36 is inserted into the shaft bore 46. In this way, changing the restraint position (engagement position) of the driven gear 37 permits the unwound length of the first wire 29*a* to be changed.

As shown in FIGS. 5 and 6, in the inner flange 39*b* of the first pulley 28*a*, a locking groove 47 is formed to which an end part of the first wire 29*a* is locked. The locking groove 47 has a locking hole 48 that is recessed in a square shape from the inner end surface of the inner flange 39*b* in the axial direction outward in the axial direction and a cut portion 49 that extends in the radial direction from the locking hole 48 to reach the outer circumferential surface of the inner flange 39*b*. Here, at one end of the first wire 29*a*, a hook portion 50 in a spherical shape is formed. The width, length, and depth of the locking hole 48 are greater than the diameter of the hook portion 50. The locking hole 48 permits the hook portion 50 to fit into it. The width of the cut portion 49 is smaller than the diameter of the hook portion 50, and greater than the thickness of the first wire 29*a*. The hook portion 50 fits in the locking hole 48, and the first wire 29*a* fits in the cut portion 49.

Since the width of the cut portion 49 is smaller than the diameter of the hook portion 50, even if the first wire 29*a* is pulled in the direction of its end opposite from the hook portion 50, the hook portion 50 is caught on the inner wall of the locking hole 48 and cannot pass through the cut portion 49. This helps prevent one end of the first wire 29*a* from coming out of the locking groove 47. The hook portion 50 can be so configured that it is fixed by being press-fitted into the locking hole 48. Instead, the hook portion 50 may be so configured that it is bonded to the locking hole 48 with adhesive or the like. The driven gear 37 may be so configured as to include a lid member that covers an end surface of the inner flange 39*b* so that, with that lid member, the hook portion 50 is locked in the locking hole 48. In that case, the lid member is structured so as not to overlap the shaft bore 46.

Referring back to FIGS. 1, 2, and 3, as described above, one ends of the wires 29*a* to 29*d* (first, second, third, and fourth wires 29*a*, 29*b*, 29*c*, and 29*d*) are fixed to the pulleys 28*a* to 28*d* (first, second, third, and fourth pulleys 28*a*, 28*b*, 28*c*, and 28*d*). The other ends of the wires 29*a* to 29*d* are fixed to the fixing portions 34*a*1, 34*a*2, 34*b*1, and 34*b*2 of the sheet stacking tray 27. Between one and the other ends of the wires 29*a* to 29*d*, the sheaves 41*a* to 41*f* are disposed. The wires 29*a* to 29*d* suspend the sheet stacking tray 27 via the sheaves 41*a* to 41*f*.

The sheaves 41*a* to 41*f* are rotatably supported at a position above the pulleys 28*a* to 28*d* (see FIG. 2). The sheaves 41*a* to 41*c* are disposed at one side (at the rear side of the housing 26) of the tray portion 33 of the sheet stacking tray 27 with respect to the axial direction, and the sheaves 41*d* to 41*f* are disposed at the other side (at the front side of the housing 26) of the tray portion 33 of the sheet stacking tray 27 with respect to the axial direction.

The other end of the first wire 29*a* (its end opposite from its end fixed to the first pulley 28*a*) is fixed to the fixing portion 34*a*1 (upstream fixing portion at the front side) located at the rear side of the housing 26. The other end of the second wire 29*b* (its end opposite from its end fixed to the second pulley 28*b*) is fixed to the fixing portion 34*b*1 (downstream fixing portion at the front side) located at the rear side of the housing 26. The other end of the first wire 29*a* is fixed to the fixing portion 34*a*1 at the side closer to the first and second pulleys 28*a* and 28*b* (at the side farther from the image forming apparatus 1) than the other end of the second wire 29*b*.

The other end of the third wire 29*c* is fixed to the fixing portion 34*a*2 (upstream fixing portion at the rear side) located at the front side of the housing 26. The other end of the fourth wire 29*d* is fixed to the fixing portion 34*b*2 (downstream fixing portion at the rear side) located at the front side of the housing 26. The other end of the third wire 29*c* is fixed to the fixing portion 34*a*2 at the side closer to the third and fourth pulleys 28*c* and 28*d* (at the side farther from the image forming apparatus 1) than the other end of the fourth wire 29*d*.

The first wire 29*a* extends from the first pulley 28*a* upward to be hooked on the sheave 41*a*, and extends from the sheave 41*a* vertically downward to suspend the sheet stacking tray 27. The second wire 29*b* extends from the second pulley 28*b* upward to be hooked on the sheave 41*b*, and extends from the sheave 41*b* horizontally downstream in the sheet conveyance direction to be hooked on the sheave 41*c*, Which is located farther from the second pulley 28*b* than the sheave 41*b*, to suspend the sheet stacking tray 27.

The third wire 29*c* extends from the third pulley 28*c* upward to be hooked on the sheave 41*d*, and extends from the sheave 41*d* vertically downward to suspend the sheet stacking tray 27. The fourth wire 29*d* extends from the fourth pulley 28*d* upward to be hooked on the sheave 41*e*, and extends from the sheave 41*e* horizontally upstream in the sheet conveyance direction to be hooked on the sheave 41*f*, which is located farther from the fourth pulley 28*d* than the sheave 41*e*, to suspend the sheet stacking tray 27.

With the weight of the sheet stacking tray 27 and the sheets P, the wires 29*a* to 29*d* applies to the suspension mechanism 60 a suspension load, which is a load acting vertically downward. The suspension load via the sheaves 41*a* to 41*f* acts as a rotative force that rotates the pulleys 28*a* to 28*d* in the reverse direction. It is assumed that, when the user presses down the sheet stacking tray 27, the pressing force adds to the suspension load.

Referring back to FIG. 1, in an upper part of the housing 26, a sheet feed mechanism 32 is disposed that feeds sheets P downstream in the sheet conveyance direction. The sheet feed mechanism 32 includes a pickup roller 53, a pair of sheet feed rollers 54, a pair of conveyance rollers 62, and a sheet discharge port 51. The pickup roller 53 is located above the sheet stacking tray 27, at a position where it makes

contact with the top surface of the stacked sheets P as the sheet stacking tray **27** ascends. When the pickup roller **53**, in contact with the top surface of the sheets P, rotates in the feeding direction (clockwise in FIG. **1**), one sheet P at the top of the stack of sheets P is fed out.

The pair of sheet feed rollers **54** are disposed opposite each other, downstream of the pickup roller **53** with respect to the sheet conveyance direction. The pair of conveyance rollers **62** are disposed opposite each other, downstream of the pair of sheet feed rollers **54** with respect to the sheet conveyance direction. The sheet discharge port **51** is located in a downstream end part of the sheet feed mechanism **32** with respect to the sheet conveyance direction, and is open in a side surface of the housing **26**. A sheet P fed downstream by the pickup roller **53** is conveyed further downstream by the pair of sheet feed rollers **54** and the pair of conveyance rollers **62**, and is discharged via, the sheet discharge port **51** out of the sheet storage device **20**. As mentioned above, to the sheet discharge port **51**, the confluence passage **52** of the image forming apparatus **1** is connected. Thus the sheet P discharged via the sheet discharge port **51** is introduced through the confluence passage **52** into the sheet feed passage **10**, is then conveyed to the image forming portion **4** inside the image forming apparatus **1**, and undergoes image formation as described above.

Next, a description will be given of adjustment of the unwound lengths of the wires **29***a* to **29***d*. FIG. **7** is a side view of the suspension mechanism **60** suspending the sheet stacking tray **27** in an inclined state. FIG. **8** is a side view of the suspension mechanism **60** in a state where, as a result of the driven gear **37** shown in FIG. **7** being rotated through a predetermined angle in the forward direction, the unwound length of the first pulley **28***a* has been reduced.

As shown in FIG. **7**, if due to deformation of the sheet stacking tray **27** or for some other reason the unwound length of the first wire **29***a* from the first pulley **28***a* is greater than the unwound lengths of the other wires **29***b* to **29***d* (second, third, and fourth wires **29***b*, **29***c*, and **29***d*) from the other pulleys **28***b* to **28***d* (second, third, and fourth pulleys **28***b*, **28***c*, and **28***d*), the sheet stacking tray **27** inclines. In this case, the driving gear **36** is pulled out of the shaft bore **46** in the driven gear **37** to remove restraint on relative rotation between the driving and driven gears **36** and **37**, and the driven gear **37** is rotated through a predetermined angle in the forward direction (winding direction of the wire). Then the projections **42** are fitted in the recesses **43** to fit the driving gear **36** in the shaft bore **46** in the driven gear **37** so that relative rotation between the driving and driven gears **36** and **37** is restrained by the locking mechanism **40**. In this way, as shown in FIG. **8**, the unwound length of the first wire **29***a* is reduced and the inclination of the sheet stacking tray **27** is eliminated.

By contrast, if the unwound length of the first wire **29***a* from the first pulley **28***a* is smaller than the unwound lengths of the other wires **29***b* to **29***d* from the other pulleys **28***b* to **28***d*, in a similar manner as described above, restraint on relative rotation between the driving and driven gears **36** and **37** is removed for a while, then the driven gear **37** is rotated through a predetermined angle in the reverse direction (unwinding direction of the wire), and then relative rotation between the driving and driven gears **36** and **37** is restrained. In this way, the unwound length of the first wire **29***a* is increased and the inclination of the sheet stacking tray **27** is eliminated.

As described above, according to the embodiment, the driven gear **37** is restrained from rotating relative to the driving gear **36** at a predetermined restraint position selected from a plurality of restraint positions. Thus, by setting the restraint position of the driven gear **37** of each of the individual pulleys **28***a* to **28***d*, it is possible to adjust the unwound length of each of the wires **29***a* to **29***d*.

As described above, the one ends of the wires **29***a* to **29***d* are fixed to the driven gear **37**, and the unwound lengths of the wires **29***a* to **29***d* change with the rotation angle of the pulleys **28***a* to **28***d*, that is, the rotation angle of the driven gears **37**. The plurality of restraint positions are located next to each other in the circumferential direction, and thus changing the restraint position of the driven gear **37** results in changing the rotation angle of the driven gear **37**. Thus, by changing the restraint position of the driven gear **37** of the pulleys **28***a* to **28***d*, it is possible to give different rotation angles to the driven gear **37** of the pulleys **28***a* to **28***d*. In this way it is possible to adjust the unwound length of each of the individual wires **29***a* to **29***d*. Even if, as mentioned above, the sheet stacking tray **27** is inclined, by adjusting the unwound lengths of each of the individual wires **29***a* to **29***d*, it is possible to set the sheet stacking tray **27** back into the horizontal state. It is thus possible to provide a sheet storage device **20** that is less prone to sheet feed failure.

As described above, the winding portion **38** has a tapered shape such that its outer diameter increases to one side in the axial direction (outward in the axial direction). Thus, when the wires **29***a* to **29***d* are wound around the winding portion **38** of the pulleys **28***a* to **28***d*, they are wound around it starting at an outer end part of the winding portion **38** in the axial direction. Thus the wires **29***a* to **29***d* are wound up flat from an outer to an inner end part of the winding portion **38** in the axial direction, and are less prone to entangling.

The embodiment specifically described above is not meant to limit the scope of the present disclosure, which thus allows for various modifications without departure from the spirit of the present disclosure. For example, while the above description deals with an example where a plurality of projection **42** are formed on the outer circumferential surface **70** of the driving gear **36**, this is not meant as any limitation; any configuration is instead possible where any number of projections **42** equal to or greater than one but smaller than the number of recesses **43** are formed on the outer circumferential surface **70** of the driving gear **36**.

The present disclosure finds applications in large-capacity sheet storage devices that can store sheets to be supplied to an image forming apparatus. Based on the present disclosure, it is possible to suppress failure in sheet feeding from a sheet storage device to an image forming apparatus.

What is claimed is:

1. A sheet storage device comprising:

a housing;

a sheet stacking tray that is supported inside the housing so as to be able to lift up and down in a lifting direction and on which a sheet is stacked;

a shaft that extends in a direction orthogonal to the lifting direction and that is supported so as to be rotatable in forward and reverse directions;

a suspension mechanism including:

a plurality of winding pulleys fitted at opposite ends of the shaft; and

a plurality of wires of which one ends are respectively fixed to the plurality of winding pulleys and of which other ends are fixed to the sheet stacking tray so as to suspend the sheet stacking tray;

a driving device that rotates the shaft; and

a drive transmission portion that transmits rotation of the shaft to the plurality of winding pulleys,

wherein

the drive transmission portion includes:
a plurality of driving gears that are respectively fixed at positions corresponding to the plurality of winding pulleys on the shaft and that rotate together with the shaft; and
a plurality of driven gears that are respectively formed on the plurality of winding pulleys and that engage with corresponding ones of the plurality of driving gears to transmit the rotation of the shaft to the plurality of winding pulleys,
the plurality of driving gears are each an external gear that has teeth formed on an outer circumferential surface of a cylindrical portion extending in an axial direction of the shaft,
the plurality of driven gears are each an internal gear that has teeth formed in an inner circumferential surface of a shaft bore recessed along the axial direction from end parts the plurality of winding pulleys in the axial direction,
between each of the plurality of driving gears and the corresponding one of the plurality of driven gears, the teeth formed on the outer circumferential surface of the cylindrical portion engage with the teeth formed in the inner circumferential surface of the shaft bore, and engagement positions of the plurality of driven gears with respect to the plurality of driving gears can be changed in a circumferential direction of the shaft,
the plurality of winding pulleys each have:
fixing portions to which an end part of one of the plurality of wires is fixed: and
a winding portion around which one of the plurality of wires is wound up, the winding portion having a cylindrical shape
the drive transmission portion changes the respective engagement positions of the plurality of driven gears and thereby changes respective relative positions of the fixing portions of the plurality of winding pulleys in a rotation direction, so as to allow adjustment of respective unwound lengths of the plurality of wires.

2. The sheet storage device according to claim **1**, wherein
the plurality of driving gears are disposed one in each of end parts of the shaft,
the plurality of winding pulleys are disposed two, adjacent to each other, in each of the end parts of the shaft, and
in each of the end parts of the shaft, the internal gears of two of the plurality of winding pulleys respectively engage with the external gear of one of the plurality of driving gears.

3. The sheet storage device according to claim **1**, wherein
the plurality of wires include four wires,
the plurality of winding pulleys include four winding pulleys to which the four wires are respectively fixed,
the four winding pulleys each include:
two front pulleys disposed adjacent to each other in a front end part of the shaft in the axial direction; and
two rear pulleys disposed adjacent to each other in a rear end part of the shaft in the axial direction,
the sheet stacking tray has:
a pair of upstream fixing portions located in a front end part and a rear end part, in the axial direction, of an upstream end part, with respect to a sheet conveyance direction, of the sheet stacking tray; and
a pair of downstream fixing portions located in a front end part and a rear end part, in the axial direction, of a downstream end part, with respect to the sheet conveyance direction, of the sheet stacking tray, and
the four wires includes:
a first wire of which one end is fixed to one of the two front pulleys and of which another end is fixed to the upstream fixing portion in the front end part;
a second wire of which one end is fixed to another of the two front pulleys and of which another end is fixed to the downstream fixing portion in the front end part;
a third wire of which one end is fixed to one of the two rear pulleys and of which another end is fixed to the upstream fixing portion in the rear end part; and
a fourth wire of which one end is fixed to another of the two rear pulleys and of which another end is fixed to the downstream fixing portion in the rear end part.

4. The sheet storage device according to claim **1**, wherein
the outer circumferential surface of the winding portion has a tapered shape such that an outer diameter of the winding portion increases outward in an axial direction of the shaft.

5. The sheet storage device according to claim **4**, wherein
the plurality of winding pulleys each has a flange formed on the winding portion, and
the fixing portions are each formed by cutting off a part of the flange.

6. The sheet storage device according to claim **5**, wherein
each of the plurality of wires has, at an end part thereof, a hook portion having a spherical shape, and
each of the fixing portions has:
a locking groove through which the plurality of wires can respectively pass; and
a locking hole that is formed in an end part of the locking groove and in which the hook portion is locked.

7. An image forming system comprising:
an image forming apparatus including an image forming portion that forms an image on the sheet; and
the sheet storage device according to claim **1** including a sheet feed mechanism that is connected to the image forming apparatus and that feeds the sheet to the image forming portion.

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